EVALUATION AND COMPARISON OF FRICTIONAL RESISTANCE BETWEEN CONVENTIONAL BRACKETS AND SELF LIGATING BRACKETS DESIGNS USING STANDARDIZED ARCH WIRES AND DENTAL TYPODONTS – AN INVITRO STUDY

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Certificate

This is to certify that **Dr. SHYLAJA. R.** *Post Graduate Student (2004-2007) in the Department of Orthodontics, Tamilnadu Government Dental College & Hospital, Chennai has done this dissertation titled "***EVALUATION AND COMPARISON OF FRICTIONAL RESISTANCE BETWEEN CONVENTIONAL BRACKETS AND SELF LIGATING BRACKETS DESIGNS USING STANDARDIZED ARCH WIRES AND DENTAL TYPODONTS AN INVITRO STUDY***" under our direct guidance and supervision in partial fulfillment of the regulations laid down by the Tamilnadu Dr.M.G.R. Medical University, Chennai for M.D.S., Branch – V Orthodontics, Degree Examination.*

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Lastly I am presenting this study as an offering to **ALMIGHTY.**

C O N T E N T S

INTRODUCTION

Friction is a force that resists the motion of two objects in contact. The direction of friction is tangential to the common boundary of two surfaces in contact. As the two surfaces in contact slide against each other two components of forces arise, the frictional component F and normal force component N are perpendicular to the contacting surface.

Friction is a clinical challenge particularly in sliding mechanics where binding of the bracket on the arch wire take place at the bracket wire interface through series of tipping and uprighting movements which signifies orthodontic tooth movements. The orthodontic literature notes numerous variables that affect the level of friction at the bracket wire interface .The orthodontic brackets have been modified in several ways to decrease the frictional resistance and improve the efficiency of sliding mechanics.Conventionally elastics and wire ligatures have been used for ligating arch wire to the brackets.

The disadvantages of conventional ligation are high friction, high initial force, slow sliding mechanics due to binding of the arch wire and they do not provide full arch wire engagement. To overcome the disadvantages of conventional ligation technique, self ligating brackets were introduced.

The advantages of self ligating brackets are decreased resistance to sliding mechanics, minimizes the chair side time due to less time consuming arch wire changes ,precise control of tooth translation, greater inter bracket span of arch wire available without binding of ligature wire or elastomeric modules, hygienic, esthetic and comfortable and ligation stability retains the original form throughout treatment.

Self-ligating brackets are ligatureless system that minimizes the normal force caused by ligation, thereby decreases the resistance to sliding. The first self ligating bracket, The Russel attachment was developed by New York Orthodontic pioneer Dr.Jacob Stolzenberg in early 1930's.

After which in mid 1970's several brackets were introduced. In 1971 Dr.Jim Wildman of Eugene developed the Edge lock Bracket System. At about the same time Dr. Herbert Hansen of Hamilton created a prototype self ligating bracket, there by in 1976, became the basic SPEED design. After which in 1986 self ligating activa bracket was designed by Dr.Erwin Pleter. In 1974 another self ligating model entered the market designed by Dr.Wolfgang Heiser of Innsbruck, Australia the "Time Bracket". Then came the Daman SL Bracket in 1996 by Dwight Daman and Twin lock bracket by Gimwildman in 1999.

Self-ligating brackets are of two types, active and passive. Active self ligating brackets apply a spring force on the arch wire until the arch wire is completely seated in the slot which is referred to as Homing action of the spring by Hansen.

They have a sliding clip which encroaches on the slot from the labial aspect potentially placing an active force on the arch wire .They also provide torque control. SPEED, Sigma, Time brackets have active clip. Passive self ligating brackets passively restrain the arch wire in the slot.

The passive brackets have a slide that opens and closes vertically and creates a passive labial surface to the slot with no intention to invade the slot and store force by deflection of metal clip. Daman SL, Edge lock, Twin lock are self ligating brackets with passive slides. Daman 2 is an improvement of the original Daman SL Bracket. The modification of the recent version include placement of slide within the tie wing, MIM and reduced size which causes reduction in frictional forces .Time 2 bracket is a modified version of time by virtue of its clip guard which prevents inadvertent slippage.

The present study aims to evaluate the friction of self-ligating brackets and comparing them in respect to reduction of friction in newer self-ligating brackets and compare them with conventional brackets with conventional ligation in both dry and wet fields.

AIMS AND OBJECTIVES

1. To compare the frictional resistance offered by conventional and self ligating brackets using A NiTi wires of various dimensions.
2. To compare the frictional resistance among the conventional brackets.
3. To compare the frictional resistance among the self ligating bracket system.
4. To compare the frictional resistance of self ligating and conventional brackets in dry and wet states.
5. To draw a conclusion to determine the optimum choice of bracket arch wire combination during fixed appliance therapy.

REVIEW OF LITERATURE

Charles A Frank and Robert J Nikolai (1980). Compared the frictional resistance between orthodontic brackets and arch wire using six independent variable, arch wire size and shape, bracket width and style, second order angulation, arch wire material, ligature force, type of ligation and interbracket distances. The result of the study showed that frictional resistance non linearly dependent upon bracket arch wire angulation. With small and generally non binding angulation bracket width and ligature force were dominant influences on the level of friction. As the angulations were increased this variable itself became the controlling parameter. Wire size and arch wire stiffness in bending apparently excerted substantial influence on frictional force magnitude at relatively high angulations.

Herbert Hanson (1980) studied the performance of SPEED appliance found that apart from saving the operator time, it permits a high degree of precision in three dimensional control of tooth that is well suited for sliding mechanics and it has the capacity to store large amounts of energy for release at desirably slow rate.

Jan G Stannard, Jeanne M, Gau. Milford (1986) compared the friction of orthodontic wires under dry and wet conditions using universal testing machine and found that artificial saliva increased the friction for stainless steel, beta titanium and Nickel titanium wires sliding against stainless steel. Artificial saliva did not increase friction for cobalt chromium, stainless steel wire on Teflon compared to dry condition. Stainless steel and B titanium wires sliding against stainless steel and stainless steel on Teflon showed lowest friction values for wet condition.

Kevin L. Baker, Lewis Neiberg, Allan D Weimer (1987) conducted a study to determine the magnitude of frictional force changes between several sizes of stainless steel wires and an edgewise bracket when artificial saliva medium was introduced. The result of study showed that introduction of saliva substitution produced significant reduction in frictional force values.

Edward F Harris, Sheldon M Newman, James A Nicholson (1988) studied the changes in mechanical properties of a Nickel titanium orthodontic wire in stimulated oral environment across time at various levels of acids. The result of the study revealed that there is significant decrease in specific Mechanical properties notably in the wire elasticity was observed in incubated wires compared with a group kept dry and unstressed.

Edward F Harris Seldon M Newman and James A Nicholson (1989) studied the changes in the mechanical properties of nickel titanium orthodontic alloy, nitinol (0.016 inch arch wires) in a simulated oral environment across time at various levels of acidity and at different amounts of static deflection. Significant decrease in specific mechanical properties were observed in incubated wires compared with a group kept dry and unstressed. In was found that the ultimate tensile strain, modules of elasticity and 2% yield strength each decreased. Acidity and amount of deflection did not affect the wire, but there was a significant monotonic decrease in yield strength with time in the stimulated oral environment. By 4 months the measure of susceptibility to permanent deformation increased by 15%. The study concluded that long term use of nitinol wire may be associated with a modest but statistically significant degradation performance notably in the limit of wire elasticity.

Deiter, Drescher, Christoph, Hans, Albert (1989) found that retarding force, surface roughness of wire, wire size, bracket width and elastic properties of wire affect friction on tooth guided arch wire mechanics in decreasing order.

Peter C Kesling (1989) introduced Tip edge a relatively new edgewise type bracket. Which provides a dynamic interaction with either round or edgewise arch wires, which in turn promote the achievement of treatment goals, increase patient comfort and enhanced ease of appliance manipulation.

Tidy (1989) studied the effect of load, bracket width, slot size, arch wire size and effect of material on frictional resistance. The result of the study revealed that arch wire dimension, slot size had little effect on friction. Nitinol and TMA arch wires produced frictional forces 2 to 5 times greater than stainless steel.

Julie ann staggers, Nicholas Germane (1991) have stated that cobalt chromium, beta titanium and nickel titanium wires produce more friction than stainless steel wires. The rectangular wires produce more friction that round wires, also he states that the wires that have the lowest friction are not necessarily the best wire for sliding mechanics.

Robert P. Kusy, John Q Whitley, Mary J, Prewitt (1991). Compared the frictional coefficient in dry and wet (saliva) states for stainless steel, cobalt chromium, nickel titanium and beta titanium against either stainless steel and polycrystalline alumina brackets. The test results revealed that in dry state regardless of the slot size, the mean kinetic friction were smallest for all stainless steel brackets and largest for the beta titanium combination. The coefficient of polycrystalline alumina combination were generally greater than the corresponding combination that included stainless steel brackets. In the wet state the kinetic coefficients of all stainless steel combination increased over the dry state.

In contrast all beta titanium wire combination in wet state showed decreased value than in dry state.

Robert R. Prosoki, Michel Bagby, leslie Erickson (1991) evaluated the frictional force and surface roughness of nickel titanium alloy arch wires using nine Nickel titanium alloy arch wires, one stainless steel alloy arch wire, one cobalt chromium alloy arch wire. The roughness of the wires were measured using profilometer in micro millimeters. The frictional resistance was quantified by pushing wire segments through the stainless steel self ligating brackets of four clinical tooth models. The cobalt chromium alloy and the nickel titanium alloy wires, with exception to sentalloy or orthonol exhibited the lowest frictional resistance. The stainless steel alloy wire was smoothest of the wire tested, whereas Niti, Marsenol, and orthonol were the roughest. No significant correlation was found between arithmetic average roughness and frictional force values.

Prasanna Kumar Shivapuja et al. (1992). Compared the conventional and self ligation bracket system for frictional resistance and found out that self ligating bracket system displayed a significantly lower level of frictional resistance, less chair side time for arch wire removal and insertion, and promoted improved infection control, when compared with polyurethane elastomeric and stainless steel tie wire ligation for ceramic and metal twin brackets.

C.R. Sundars and R.P. Kusy (1994). Studied the surface topography and frictional characteristics of single crystal sapphire and polycrystalline alumina brackets in both dry and wet states as a function of four basic alloy composition and came out with the conclusion that arch wire alloy rather than bracket product type or surface roughness, influence the frictional characteristic the most. The titanium wires generally cause higher frictional resistance than either stainless steel or cobalt chromium.

David J. De Franco, Robert E spiller, Von Fraunhofer (1994). Compared the static frictional resistance between Teflon coated stainless steel and clear elastomeric ligatures using stainless steel, polycrystalline ceramic, single crystal ceramic brackets in combination with stainless steel and nickel titanium wires. The outcome of the study showed that ceramic brackets elicited greater frictional resistance than stainless steel brackets.

Jeffrey L. Berger et al (1994). In his article "The SPEED appliance" have described the various integral components of the speed appliance and its function. He describes that each speed attachment consist of four components a bracket body, a permanently installed spring clip, an in out adaptor and a foil mesh bonding base. The function of speed appliance are rotational control, Tip control, Torque control, continuous force delivery and Low frictional coefficient.

George V. Corbittit (1995) have stated that elastomeric ring exhibit increased frictional forces compared with the Teflon coated wires.

Nigel G, Taylor, Keith Isor (1995). Studied the frictional resistance between orthodontic brackets and arch wires by using 3 types of bracket (pre adjusted edge wise premolar bracket). Activa bracket and speed brackets combined with five wire sizes. The results of the study showed that activa brackets produced the least friction for all wires. The speed bracket with round wires showed little frictional force, while rectangular wires showed higher forces, at levels similar to those recorded with standard straight wire brackets. The ratio of static to dynamic friction was remarkably consistant in all tests.

Janet L. Vaughan, Manville G. Duncanson. Ram .S Nanda (1995). Compared the relative kinetic frictional forces during translation at the bracket wire interface using two sintered stainless steel bracket with two slot size, four wires and five to eight wire sizes. The two types of stainless steel brackets were tested in 0.018inch and 0.022inch slots. Wires of four different types, stainless steel cobalt chromium and Nickel titanium were tested. The bracket movement along the arch wire was implemented by mechanical testing machine. The study concluded that lower frictional forces was generated with Stainless Steel and Cobalt Chromium wires than with B titanium and Nickel wires.

Nigel W.T. Harradine, David J. Birnie (1996) have enumerated the advantages and disadvantages of activa self ligating brackets. The clinical advantages of activa brackets are low friction, excellent control of arch wire engagement, rapid alignment of irregular teeth, lower anchorage requirements and facilitation of sliding mechanics but the most significant drawback is bond failure which is higher than with conventional brackets from the same manufactures.

Eleni Bazakidou, Ram S Nanda, Manville G Duncanson (1997) studied and compared the frictional forces generated between composite ceramic and metal brackets. Study was conducted with selected wire alloy combinations with elastomeric and stainless steel ligatures in a dry environment. Four types of composite, one ceramic, one sapphire and one metal bracket were tested with stainless steel nickel titanium and Beta titanium wires. The testing was performed with two wire sizes in the 0.018 inch slot brackets and three wire sizes in 0.022 slot brackets. The recently introduced composite brackets were found to offer lower frictional resistance than the ceramic and stainless steel brackets, regardless of the wire size, wire alloy and type of ligation. The wire alloy with the least friction was stainless steel, followed by B titanium and nickel titanium. Mean variability in friction, as reflected by the magnitude of standard deviations was 2.7 to 3 times more with the stainless steel ligation that elastomeric ligation.

Torstein R Meling, Jan Odegaard, Kjell Holthe and Dieter senger (1997) investigated that the effect of friction on binding stiffness of orthodontic beams. A theoretical and experimental model have been established, where tensile and compressive forces are applied to an arch wire to simulate the effect of additional friction during activation and de activation respectively. The result showed that tensile force increased wire stiffness, and that compressive force increased the wire flexibility. Thus requires more force during activation. The amount of force lost increased linearly with increasing friction. During activation the percentage of increase in force due to friction for a given deflection is about equal to the loss of force due to friction during deactivation.

Dwight H, Daman (1998) have presented an article to describe a hightech friction free system. 'The Daman SL system' which provides nearly friction free mechanics with hightech brackets and wires. The advantages of the system is its dynamic impact on cellular biology and on bone, tissues and muscle physiology.

Robert P. Kusy. John Q Whitley, Michael J, Mayhew (1998). Studied the surface roughness of six representative orthodontic arch wire using specular reflectance. In the study it was found that stainless steel appeared the smoothest, followed by chrom-cobalt, beta titanium and nickel titanium.

Rupali Kapur, Pramod Sinha, Ram S, Nanda (1998). Compared the kinetic friction of new selfligating bracket Damon SL and conventional Minitwin brackets using 0.018 x 0.025 NiTi and 0.019 x 0.025 SS wires. The result of the study showed that the Damon SL showed significant lower kinetic frictional forces than Minitwin brackets with both wires indicating that self ligating brackets not only make arch wire placement more convenient and secure but also have lower kinetic frictional force than conventional brackets.

Torstein R. Melling et al (1998). Studied the variability of cross section dimensions and torisonal properties of rectangular nickel titanium arch wire using twenty five rectangular superelastic and work hardened nickel titanium alloy wires with 0.018 inch edge wise technique supplied by seven different manufactures. The results revealed that torisional stiffness varied among the manufacturers within the various wire size and this being the result of differences in actual cross section geometry and material properties. None of the wires exhibited super elasticity when activated above 25^{O}. when activated beyond 25^{O} demonstrated hysterics.

Herbert Hanson (1999). In his article described the wingless SPEED bracket system which is an improved form and described its advantages. In this wingless speed bracket system the absence of tie wing allows addition of auxillary slot lending considerable versatility of miniaturized bracket system.

Rupali Kapur, Pramod K, Sinha, and Ram Nanda (1999) measured and compared the level of frictional resistance generated with a non repeated and repeated experimental design to evaluate whether the wear in the bracket slot will influence frictional resistance. Both 0.018 and 0.022 inch slot size edgewise brackets were tested in a specially designed apparatus. The frictional resistance was measured on an Instron Universal testing Mechine. A repeated ANOVO was used to determine differences among the 10 individual bracket wire specimens for each combination to study the influence of wear on static and kinetic frictional force. A paired t test was used to compare the static and kinetic frictional forces in the non repeated and repeated study for each bracket slot, wise size and bracket type. The result showed that the mean frictional force was higher with the repeated use of brackets.

Jeff Berger (2000) have enumerated the various advantages of self ligating bracket system over conventional bracket system. The advantages of self ligating bracket over conventional bracket are light initial force, low friction, reduced risk of injury, initial few arch wire changes, ligation stability, shorter visits, good oral hygiene efficient sliding mechanics, reduced treatment time and treatment duration.

Jeff Berger, Fredrich Byloff (2001) conducted a mail survey to measure the orthodontists clinical impression of self ligating bracket. In the survey nearly all clinicians believed that they saved time changing arch wires with selfligated SPEED brackets. More over it is an extremely cost effective treatment technique.

D.V. Smith, P.E. Rossouw, R. Pillar (2001). Conducted a study to evaluate the frictional resistance between orthodontic brackets and arch wires with sliding mechanics using quantified stimulation of canine retraction. The study revealed that orthodontic brackets ceramic bracket with or without a metal slot had the greatest friction followed by metal brackets, activa selfligating brackets, and variable selfligating brackets for orthodontic arch wires. The stainless steel and twisted stainless steel showed greater friction than did the nickel-titanium; smaller dimension wires showed less friction than larger wires and round wires showed less friction that large wires.

G Williems K, Clocheret J, P celis (2001). Conducted a pilot study to evaluate the frictional behaviour of stainless steel bracket wire combinations subjected to small oscillating displacement. In the study a fretting test consisting of reciprocating tangential displacement was used to investigate test parameters influencing frictional force during sliding processes. The results of the study showed that when centered bracket positioning was not used significantly higher coefficient of friction was found for both bracket wire-combinations. Also the slot filling bracket wire combinations resulted in increased coefficient of friction.

Glenys A. Thorstenson BS and Robert P. Kusy (2001). Compared the frictional properties of conventional stainless steel brackets that were coupled with rectangular stainless steel arch wires and those ligated with stainless steel ligature wire and the frictional properties of closed self ligating brackets coupled with second order angulation. In the study it was found that, in passive configuration the conventional brackets exhibited similar frictional resistance as open self legating brackets, whereas the closed self ligating brackets exhibited no friction in active configuration. All brackets exhibited increased resistance to sliding as the angulation is increased.

Peter D Wilkinson Peter Dysart James A Hood (2002). Studied the load deflection characteristics of Nickel titanium orthodontic wires using 5 different model designs at 3 temperature and 4 deflection distances. The study revealed that effects of model wire and temperature variation were all statistically significant. The twistflex and the 5 HASN wire produced a range of broadly comparable results and NiTi gave the highest unloading values. Model rankings indicated that self ligating Twin lock brackets produced lower friction than regular edgewise bracket.

Glenys A, Thorstenson, Robert P. Kusy (2002). Compared the resistance to sliding between different self ligating brackets with second order angulation using 3 self ligating brackets with passive slides and self ligating brackets having active clips. It was found that below critical contact angle brackets with passive slides exhibited negligible friction and the brackets with active clip exhibited greater friction. Above each contact angle, all brackets had elastic binding forces that increased at similar rates as the angulation increased and were independent of bracket design.

Glenys A. Throstenson and Robert Kusy (2002). Studied the effect of arch wire size and material on resistance to sliding of self ligating brackets with second order angulation using four designs of self ligating brackets coupled with 5 type of arch wire. The results showed that the resistance to sliding depends on the clearance between the arch wire and the bracket. When clearance exists the resistance to sliding was comprised of a frictional component and binding component which increased as the second order angulation increased above the critical contact angle.

Edward Mah, Micheal Bagby, Peter Ngan and Mark Durkee (2003). Conducted a study to determine whether self ligating brackets produced less friction than conventional brackets when variable moments were applied at the bracket arch were interface, 4 types of brackets with 6 different arch was used in the study and the results of the study suggested that self ligating brackets produce less dynamic friction than conventional brackets, and larger diameter wire produce greater amount of dynamic friction.

Emile Rossouw, Lornes Kamelchek, and Robert Kusy (2003) describe about the variables associated with low velocity and oscillatory motion characterised by cycles of sticking and slipping which produces steady instability thus rendering sliding estimates inapplicable. Factors such as lubrication and abrasive interactions during sliding of two opposing surfaces are related to slip-stik phenomenon and they are secondary to sliding when an intervening layer is present, factors such as constitution surface tension also affects the frictional force.

Kevin Mendes P. Emile Rossouw (2003) evaluated the effects of ion implantation on arch wire and bracket surface and compared it with other friction reducing modalities. The result of the study suggested that ion implantation of nickel titanium as well as bracket surface are effective means to reduce friction. An even greater reduction in friction can be obtained by offsetting the friction from elastomeric ligation as with design like that of synergy bracket and use of ion implanted wires.

Laura R. Iwasaki Mark W Beatty and Jeffrey Nickel (2003). Studied the effects of moments and ligation effect on friction and suggested that vibration introduced did not eliminate the friction. Tipping moment and ligation forces were equally significant in determining frictional forces. As well there are considerable intraoperator variation in force of ligation for SS ligatures. Variation in clinical ligation forces for likely to be equal or greater than these experimental data and have potential to affect treatment efficiency during orthodontic sliding.

Lorne S. Kamelechuk and Emile Rossouw (2003) evaluated the kinetic friction using a prototype testing machine. Results of the operating friction trails are reported as a function of intergrated and quantified angular and linear bracket movements. It is concluded that the testing apparatus presented has the ability to allow for high standard or hypothesis testing product development, quality control and product performance evaluation with relative ease.

N.W.T Harradine (2003) states that self ligating bracket offer the very valuable combination of extremely low friction and secure full bracket engagement.

P. Emile Rossouw (2003) defines friction is a force that retards or resist the relative motion of two objects in contact. During tooth movement, which occurs through series of tipping and uprighting binding of arch wire takes place at the bracket and arch wire interface. This creates friction. More over it also describes about the variables affecting friction during sliding mechanics like size and shape of the arch wire, type of ligation, bracket properties and the biologic factors.

Robert P. Kusy John Q. Whitley (2003). Evaluated the frictional coefficients in sliding mechanics using four media, a control dry state whole human saliva; deionized water; and five artificial salivas (Moi-stir, Orex, Salivert, saliva substitute and Xero-lube). The out come of study showed only saliva can be used to assess friction and its coefficients in wet state. The control, dry state ranks next, followed by other fluid media.

Wolf gang Heiser (2003) states that Time brackets produce low friction and prevent unwanted rotations during retraction because of spring clips and light force tendencies. Also the early torque control from the interactive clip permits the treatment to be finished sooner.

Sandra P, Henao BS, Kusy BS (2004) evaluated the frictional resistance of conventional and self ligating bracket design using standardized arch wires of varied dimension and stated that smaller dimensions wires to be used during aligning and leveling phase.

Simona Tecco, Felice Festa, Sergio Caputi (2005) compared the frictional resistance generated by conventional stainless steel brackets self ligating Damon SL II bracket and Time plus brackets coupled with stainless steel. Nickel titanium and Beta titanium arch wire. The Damon SL II brackets generated significantly lower friction than the other brackets when tested with round wires and significantly higher friction than Time plus when tested with rectangular arch wires.

Darryl V. Smith, P Emile Rossouw and Philip Watson (2003) evaluated the frictional resistance of various bracket arch wire combinations using friction testing apparatus which allowed dynamic and progressive bracket traction during experimentally approximated canine retraction. The results of the study showed that ceramic bracket with or without metal slots had the greatest friction followed by metabrackets, activa self ligation brackets, variable self ligating brackets. Stainless steel and braided stainless arch wire measured greater friction than larger wires and round wires showed friction greater than rectangular wire.

Micheal Tselepsis, Peter Brockhurst and Victor C west studied and quantified the dynamic frictional force of sliding between different modern orthodontic brackets and arch wires. Arch wire angulation and lubrication were the variables used in the study. The frictional force were measured by universal testing machine. The study showed that polycarbonate brackets showed the highest friction than stainless steel brackets with bracket arch wire angulation. Whereas lubrication decreased the friction.

Peter G Miles, Robert J Weynath, Luis Rustveld (2006) compared the effectiveness of Damon 2 brackets and conventional twin brackets during initial alignment in sixty consecutive patient by bonding one side of lower arch with Damon 2 brackets and the other side with conventional twin bracket. It was found that Damon 2 brackets were was no better than conventional bracket. Initially Damon 2 bracket was less painful, but it was more painful when placing the second arch wire and had a higher bracket failure.

MATERIALS AND METHODS

The present study is done to evaluate and compare the frictional resistance offered by conventional and self ligating brackets employing A NiTi wires of various dimension (0.014inch, 0.016 x 0.022inch & 0.019 x 0.025 inch) using dental typodonts.

Typodonts selected

Acrylic typodont models replicated from a patient's oral cavity that displayed misalignment of teeth before treatment in both the upper and lower arches were used for the study.

Brackets selected

4 Types of Brackets were used for the study

2 - Conventional Brackets

2 - Self ligating Brackets

Conventional Brackets used were

1. Gemini Roth .022 slot Brackets
2. T.P Tip Edge Brackets

Self ligating Brackets used were

1. Time – 2 Brackets
2. Damon – 2 Brackets

Arch wires used

A NiTi wires - 0.014inch Round

- 0.016 x 0.022inch rectangular
- 0.019 x 0.025inch rectangular

Ligatures used

- Elastomeric modules Power O modules ormco

Human Saliva

Syringe

Machine used

LLOYD universal testing Machine with load cell capacity of 10 kg was used for the study.

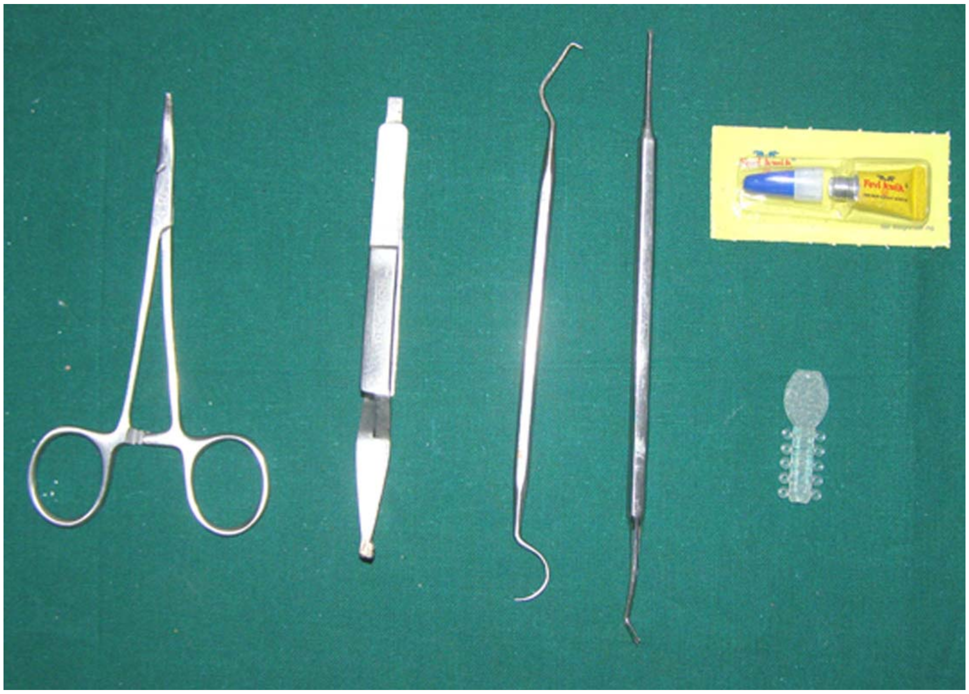
Procedure :- The procedure was done in Central Institute of Plastics Engineering and Technology with the help of Instron Universal Testing Machine. The drawing force values were evaluated in four quadrants: lower Right (LR) upper Left (UL) Lower left (LL) and Upper Right (UR) A ranking of the quadrants were done relative to the degree of malocclusion which was determined by subjectively examining each quadrant and objectively applying a variant of Little's Irregularity Index that incorporated three dimensions. The order of the Rank was from the least malocclused quadrant to the most malocclused quadrant: (LR, UL, LL, and UL). For all self ligating and conventional brackets test were done in dry state. The self ligating Daman 2 and Gemini Roth brackets were also tested in wet stated using only the 0.014 inch A Niti wires. Conventional brackets were ligated with elastic modules power ormco modules.

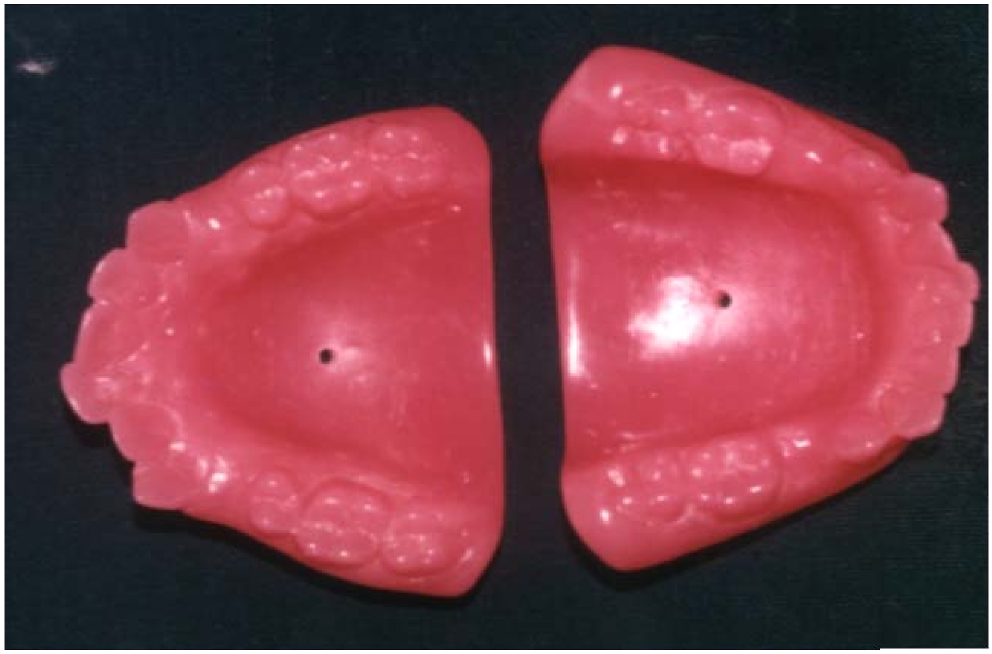
Friction evaluation was done by attaching the typodont model to the lower head of mechanical testing machine using an acrylic plate and the distal end of the wire was attached to the movable upper head which moved superiorly. The cross head was adjusted to a speed of 0.5mm/ min in tensile mode. The frictional resistance was measured and the values were displayed on the computer screen in Newton along graph on X-Y records. Each sample consists of 4 brackets along with one arch wire. Friction was measured in centi newtons at every 0.25mm displacement for 2mm resulting in 8 reading for each sample. Each run was approximately 5 minutes.

CONVENTIONAL BRACKETS - GEMINI ROTH BRACKETS AND TIP EDGE BRACKETS – 0.022 SLOT

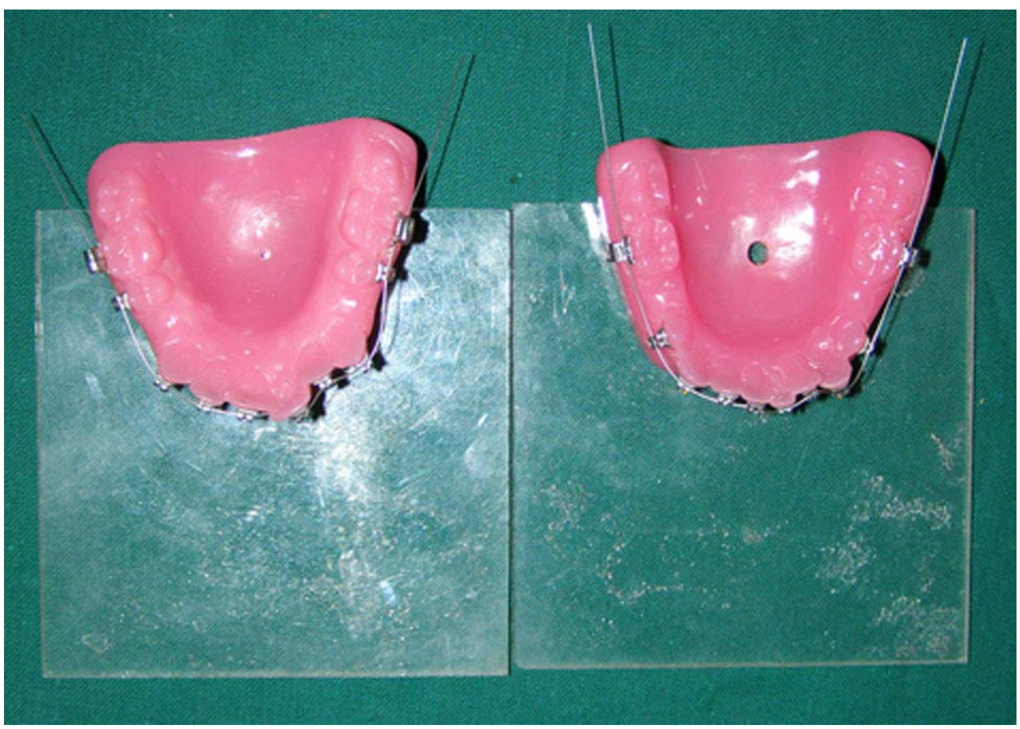
SELF LIGATING BRACKETS – TIME 2 BRACKETS AND DAMON 2 BRACKETS 0.022 SLOT

ARMAMENTARIUM

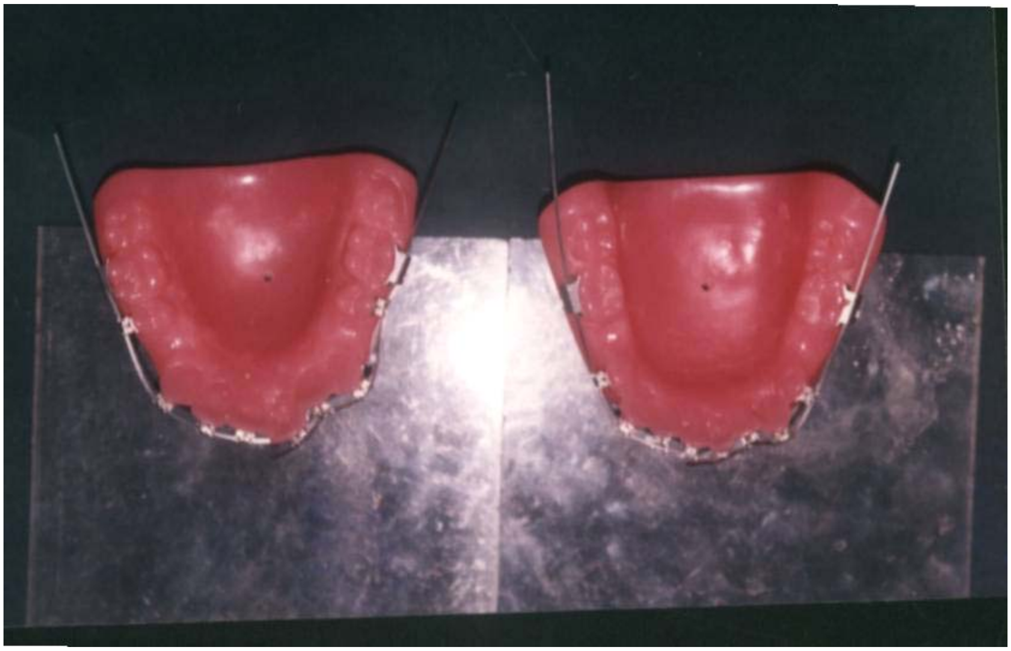




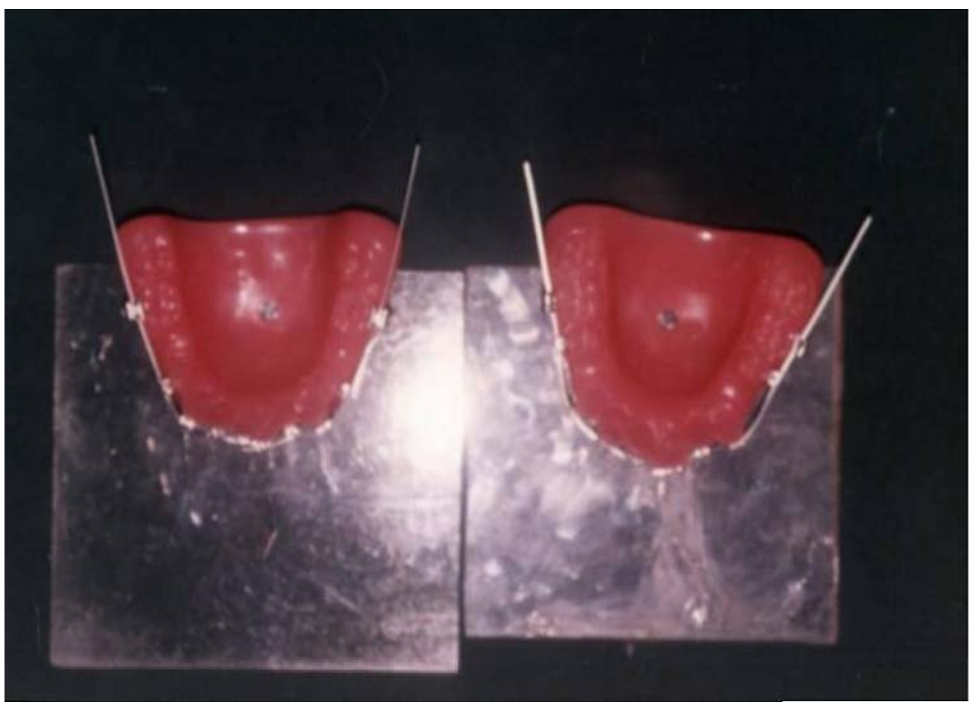
TYPODONT MODELS DEPICTING VARYING DEGREE OF MALOCCLUSION



BRACKETS WITH 0.014INCH WIRES

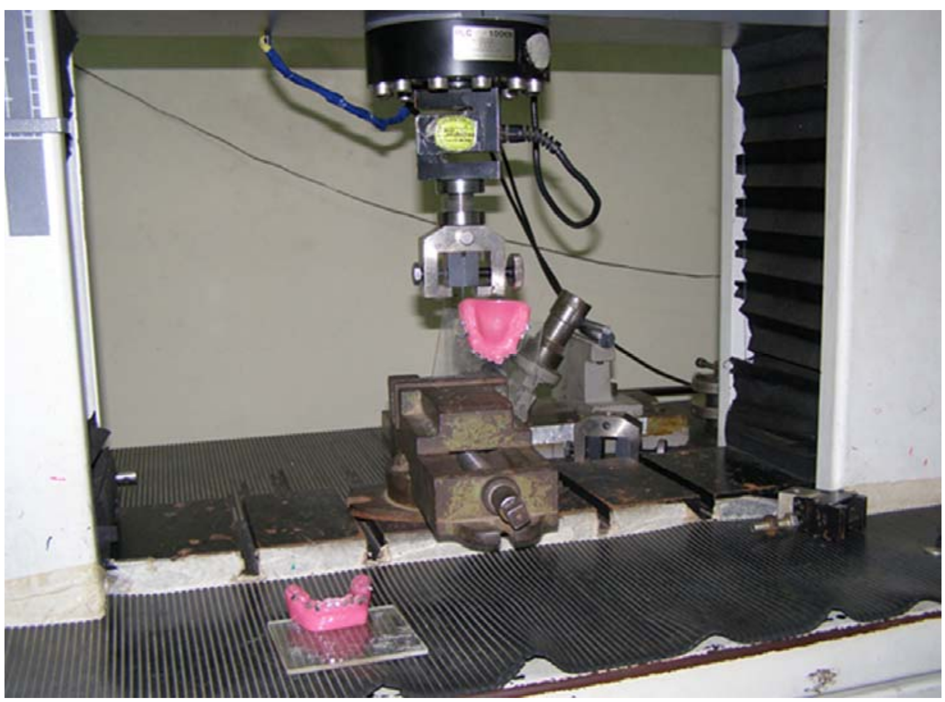


BRACKETS WITH 0.016 x 0.022 INCH WIRES



BRACKETS WITH 0.019 x 0.025 INCH WIRES

LLOYD UNIVERSAL TESTING MACHINE



LLOYD UNIVERSAL TESTING MACHINE HOLDING TYPODONT MODEL

RESULTS

The results of the study showed that for 0.019 x 0.025 inch A NiTi wires in dry state the maximum mean value was seen with Gemini Roth brackets 2625 cN followed by Time 2 brackets 2100 cN followed by Damon 2 brackets 1650 cN. The lowest mean value for 0.019 x 0.025 inch. A Niti wires was seen Tip edge brackets 1370 cN.

For 0.016 x 0.025 inch A NiTi wires in dry state the maximum mean value was seen with Gemini Roth bracket 1190 cN followed by Tip Edge brackets 845 cN followed by Time 2 brackets 840cN. The lowest mean value for 0.016 x 0.025 inch A NiTi wires was found with Damon 2 brackets 730 cN.

For 0.014 inch A NiTi wires in dry state the maximum mean value was seen with Tip Edge brackets 975 cN followed by Gemini Roth brackets 960 cN followed by Damon 2 brackets 825 cN. The lowest mean value for 0.014 inch wires was seen with Time 2800 cN. Similar range of values were found by Sandra. P in his studies.

In both conventional and self ligating methods force values of the brackets coupled with A NiTi wires were compared with regard to lower right, upper left and lower left, and upper right quadrants based on the ‘P’ value obtained in students ‘t’ test.

In conventional method with 0.019 x 0.025 inch A NiTi wire when the Gemini Roth and Tip Edge brackets were compared there was significant difference found between the force values in all the quadrants except for the lower right quadrant where minimum force values were compared. With 0.016 x 0.022 inch A NiTi wires and 0.014 inch A NiTi wires when Gemini Roth and Tip Edge brackets were compared there was significant difference found between the force values in all the four quadrants.

In self ligating method with 0.019 x 0.025 inch A NiTi wires and 0.016 x 0.025 inch A NiTi when Damon 2 and Time 2 brackets were compared there was significant difference found in the force values in all the quadrants. With 0.014 inch wires when Damon 2 and Time 2 brackets were compared significant difference in force values were found between brackets in all quadrants except in the lower left quadrant.

MASTER CHART

IN DRY STATE, RANGE OF FORCE VALUES IN CENTI NEWTON FOR CONVENTIONAL BRACKETS IN FOUR QUADRANTS

Brackets	Wire size (inch)	Wire sample	Lower Right		Upper Left		Lower Left		Upper Right	
			Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
Gemini Roth	0.014	1	180	600	190	770	260	810	490	950
		2	220	710	180	720	300	840	510	970
	0.016 x 0.022	1	510	1010	610	1120	-	-	-	-
		2	530	1040	620	1260	-	-	-	-
	0.019 x 0.022	1	620	1930	820	2620	-	-	-	-
		2	680	1980	936	2630	-	-	-	-
Tip Edge	0.014	1	130	480	220	680	310	820	530	960
		2	140	490	250	650	300	810	570	990
	0.016 x 0.022	1	350	680	410	850	-	-	-	-
		2	310	730	440	840	-	-	-	-
	0.019 x 0.022	1	530	1120	620	1390	-	-	-	-
		2	590	1180	630	1350	-	-	-	-

Wires are all NiTi A,
Quadrants in which any or all of the wires do not engage into the bracket slot, as shown by the dash

IN DRY STATE, RANGE OF FORCE VALUES IN CENTI NEWTON FOR SELF LIGATING BRACKETS IN FOUR QUADRANTS

Brackets	**Wire size**	**Wire sample**	**Lower Right**		**Upper Left**		**Lower Left**		**Upper Right**	
			Minimum	**Maximum**	**Minimum**	**Maximum**	**Minimum**	**Maximum**	**Minimum**	**Maximum**
Time 2	0.014	1	30	50	55	125	450	740	550	810
		2	35	55	65	110	390	693	580	790
	0.016 x 0.022	1	490	690	580	850	-	-	-	-
		2	450	710	570	830	-	-	-	-
	0.019 x 0.022	1	750	1690	1290	2060	-	-	-	-
		2	830	1850	1370	2140	-	-	-	-
Damon 2	0.014	1	20	35	160	300	210	580	440	820
		2	25	40	140	320	250	510	555	850
	0.016 x 0.022	1	160	500	660	710	-	-	-	-
		2	140	490	590	750	-	-	-	-
	0.019 x 0.022	1	360	910	810	1640	-	-	-	-
		2	440	1101	790	1670	-	-	-	-

Wires are all NiTi A,
Quadrants in which any or all of the wires do not engage into the bracket slot, as shown by the dash

IN WET STATE, RANGE OF FORCE VALUES IN CENTI NEWTONS FOR A CONVENTIONAL AND A SELF LIGATING BRACKET DESIGNS IN FOUR QUADRANTS

Brackets	**Wire size**	**Wire sample**	**Lower Right**		**Upper Left**		**Lower Left**		**Upper Right**	
			Minimum	**Maximum**	**Minimum**	**Maximum**	**Minimum**	**Maximum**	**Minimum**	**Maximum**
Gemini Roth	0.014inch	1	260	490	390	410	530	1080	610	1220
		2	310	530	790	820	490	1000	590	1160
Damon 2	0.014inch	1	45	55	120	210	260	420	570	880
		2	40	50	110	260	250	450	460	850

Wires are all NiTi A,

Table I

Force values of conventional Brackets with 0.014 inch wires

CONVENTIONAL BRACKET					
	GEMINI ROTH		TIP EDGE		P Value
	Mean	SD	Mean	SD	
LR Minimum	200.00	28.28	135.00	7.07	0.088
LR Maximum	655.00	77.78	485.00	7.07	0.091
UL Minimum	185.00	7.07	235.00	21.21	0.087
UL Maximum	745.00	35.36	665.00	21.21	0.111
LL Minimum	280.00	28.28	205.00	7.07	0.092
LL Maximum	825.00	21.21	815.00	7.07	0.089
UR Minimum	500.00	14.14	550.00	28.28	0.053
UR maximum	960.00	14.14	975.00	21.21	0.112

Mean –Force values in Centi Newton, P value > 0.05 statistically significant.

Table II

Force values of self ligating brackets with 0.014 inch wires

SELF LIGATING BRACKETS					
	TIME 2		DAMON 2		P Value
	Mean	SD	Mean	SD	
LR Minimum	32.50	3.54	22.50	3.54	0.038
LR Maximum	52.50	3.54	37.50	3.54	0.050
UL Minimum	60.00	7.07	150.00	14.14	0.015
UL Maximum	117.00	10.61	310.00	14.14	0.004
LL Minimum	420.00	42.43	230.00	28.28	0.118
LL Maximum	715.00	35.36	545.00	49.50	0.264
UR Minimum	565.00	21.21	497.00	81.32	0.018
UR maximum	800.00	14.14	835.00	21.21	0.021

Mean –Force values in Centi Newton, P value > 0.05 statistically significant.

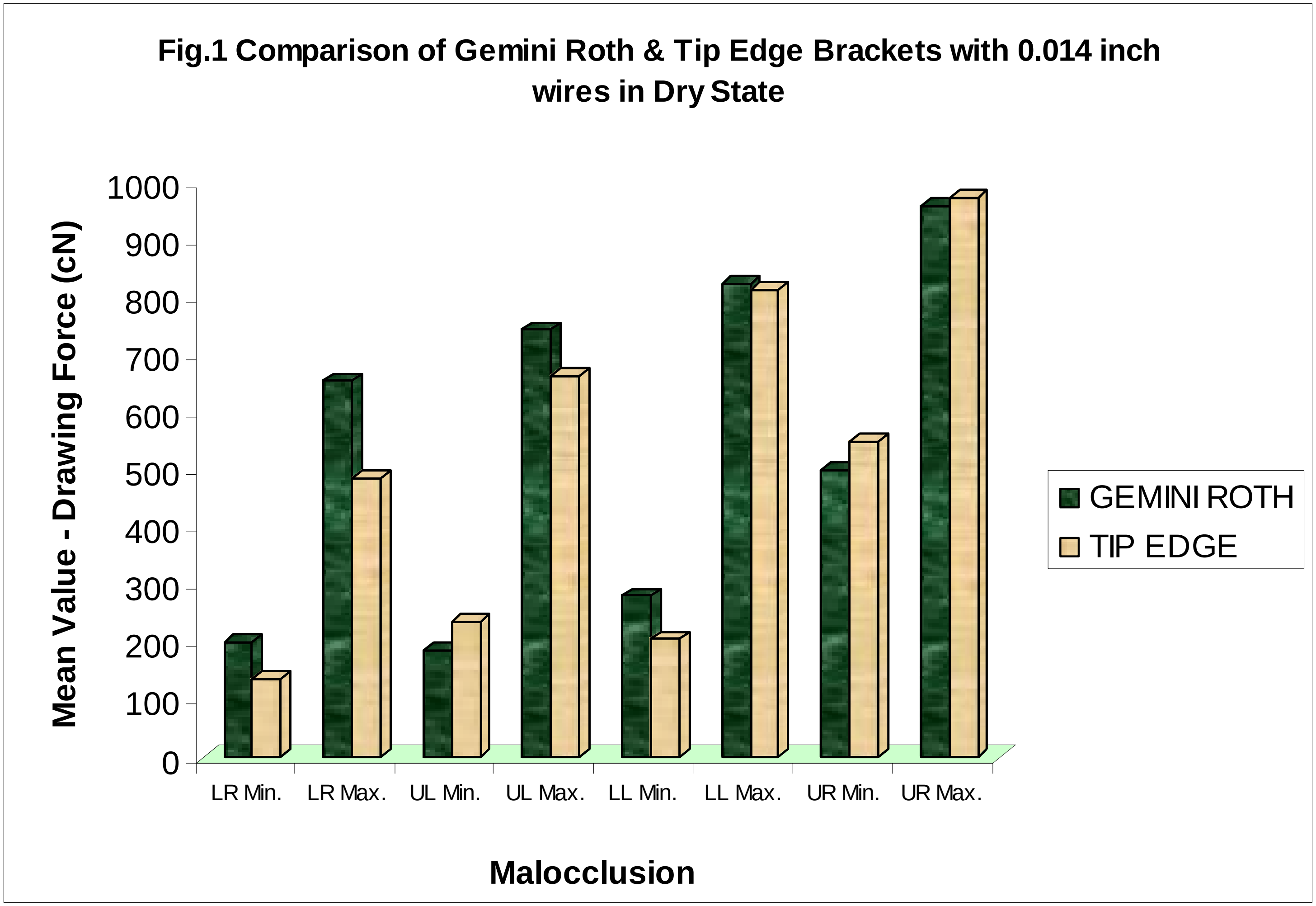


Fig.1 Comparison of Gemini Roth & Tip Edge Brackets with 0.014 inch wires in Dry State
Mean Value - Drawing Force (cN)
0
100
200
300
400
500
600
700
800
900
1000
LR Min.
LR Max.
UL Min.
UL Max.
LL Min.
LL Max.
UR Min.
UR Max.
Malocclusion
GEMINI ROTH
TIP EDGE

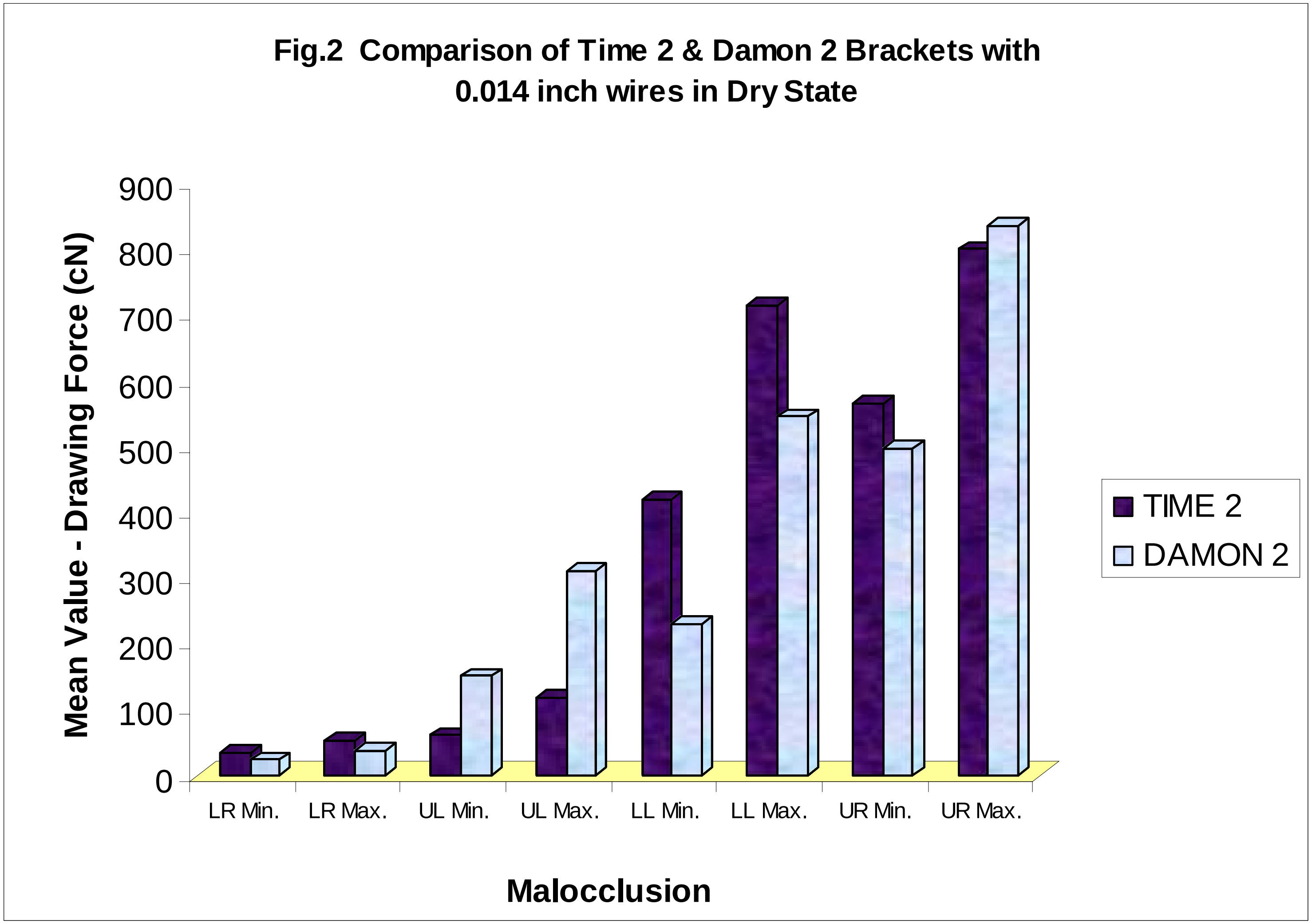


Fig.2 Comparison of Time 2 & Damon 2 Brackets with
0.014 inch wires in Dry State
Mean Value - Drawing Force (cN)
900
800
700
600
500
400
300
200
100
0
LR Min.
LR Max.
UL Min.
UL Max.
LL Min.
LL Max.
UR Min.
UR Max.
Malocclusion
TIME 2
DAMON 2

Table III

Force values of conventional Bracket with 0.016 x 0.022 inch wires

CONVENTIONAL BRACKET					
	GEMINI ROTH		TIP EDGE		P Value
	Mean	SD	Mean	SD	
LR Minimum	520.00	14.14	330.00	28.28	0.014
LR Maximum	1025.00	21.21	705.00	35.36	0.008
UL Minimum	615.00	7.07	425.00	21.21	0.007
UL Maximum	1190.00	98.99	845.00	7.07	0.039

Mean –Force values in Centi Newton, P value > 0.05 statistically significant.

Table IV

Force values of self ligating bracket with 0.016 x 0.022 inch wires

SELF LIGATING BRACKET					
	TIME 2		DAMON 2		P Value
	Mean	SD	Mean	SD	
LR Minimum	470.00	28.28	150.00	14.14	0.005
LR Maximum	700.00	14.14	495.00	7.07	0.003
UL Minimum	575.00	7.07	625.00	49.50	0.293
UL Maximum	840.00	14.14	730.00	28.28	0.039

Mean –Force values in Centi Newton, P value > 0.05 statistically significant.

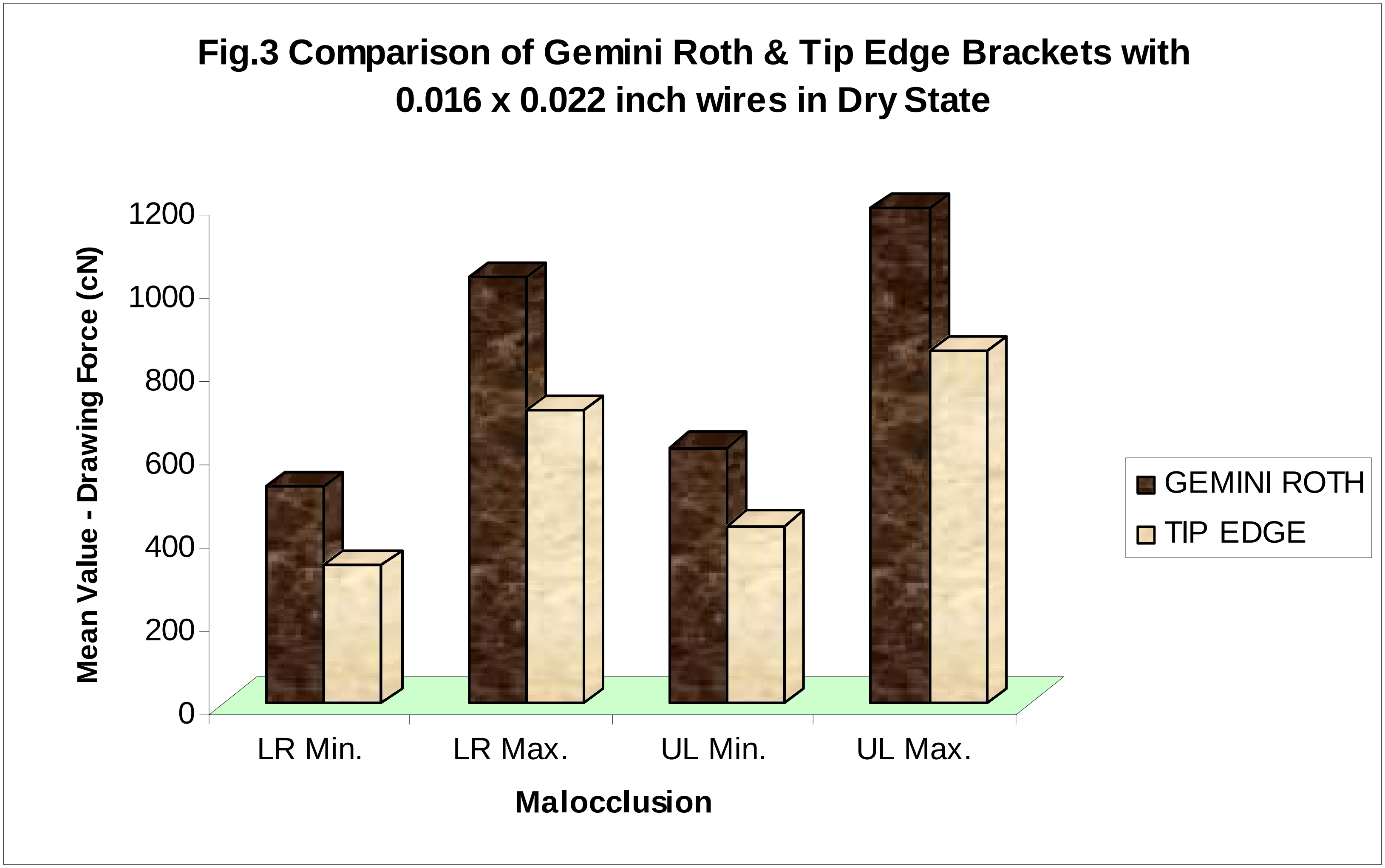


Fig.3 Comparison of Gemini Roth & Tip Edge Brackets with
0.016 x 0.022 inch wires in Dry State
Mean Value - Drawing Force (cN)
1200
1000
800
600
400
200
0
LR Min.
LR Max.
UL Min.
UL Max.
Malocclusion
GEMINI ROTH
TIP EDGE

Fig.4 Comparison of Time 2 & Damon 2 Brackets with 0.016 x 0.022 inch wires in Dry State

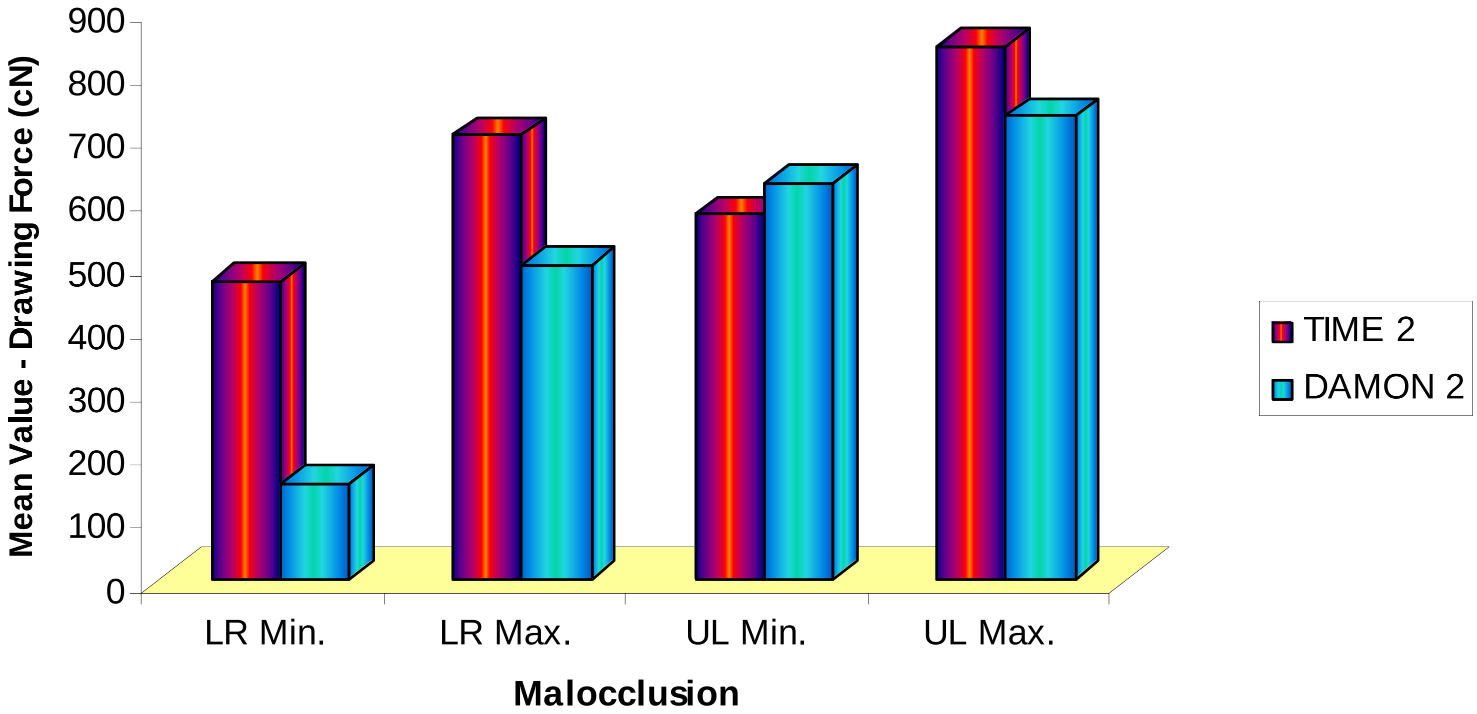


Table V

Force values of conventional bracket with 0.019 x 0.025 inch wires

CONVENTIONAL BRACKET					
	GEMINI ROTH		TIP EDGE		P Value
	Mean	SD	Mean	SD	
LR Minimum	650.00	42.43	560.00	42.43	0.168
LR Maximum	1955.00	35.36	1150.00	42.43	0.002
UL Minimum	878.00	82.02	625.00	7.07	0.049
UL Maximum	2625.00	7.07	1370.00	28.28	0.001

Mean –Force values in Centi Newton, P value > 0.05 statistically significant.

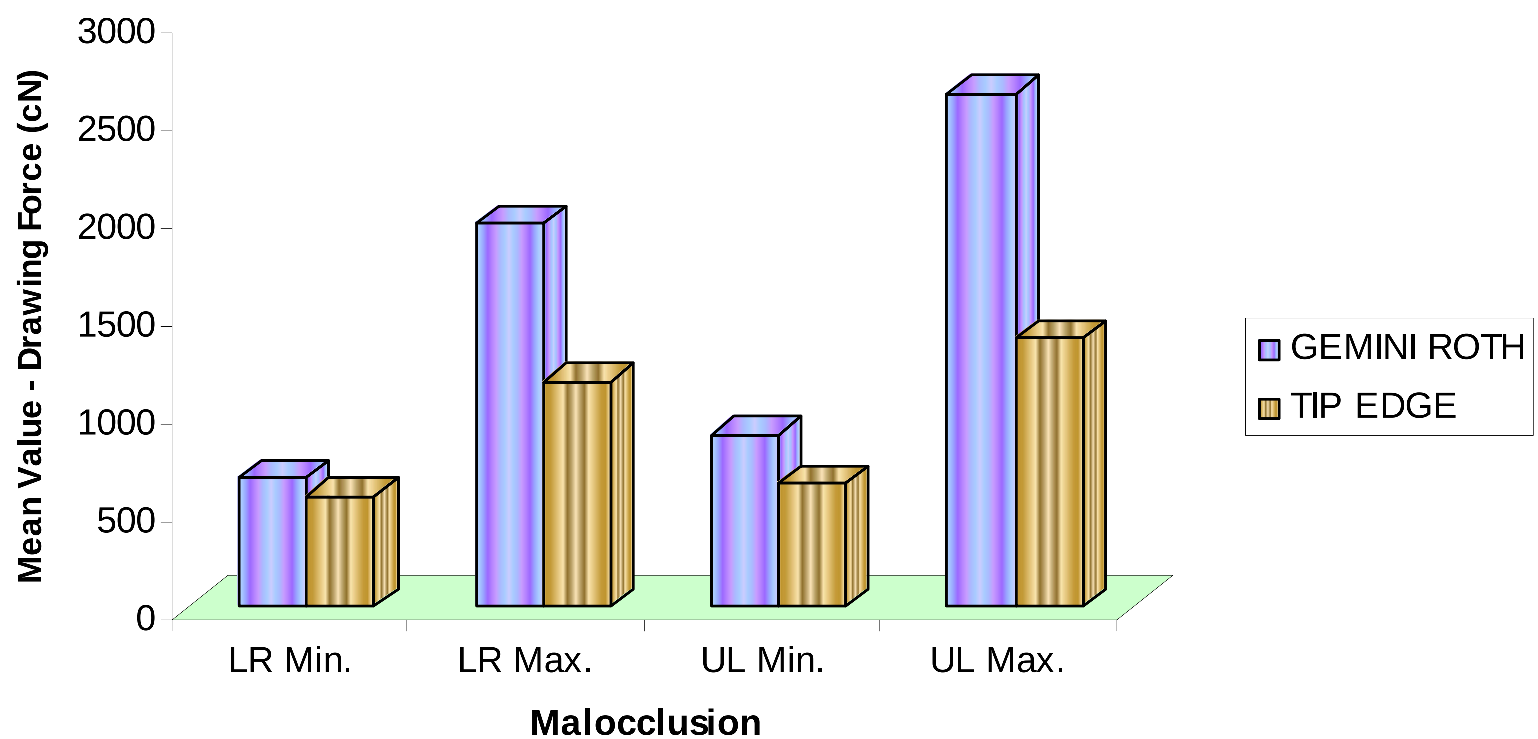
Table VI

Force values self ligating bracket with 0.019 x 0.025 inch wires

SELF LIGATING BRACKET					
	TIME 2		DAMON 2		P Value
	Mean	SD	Mean	SD	
LR Minimum	470.00	28.28	150.00	14.14	0.020
LR Maximum	700.000	14.14	495.00	7.07	0.026
UL Minimum	575.00	7.07	625.00	49.50	0.006
UL Maximum	840.00	14.14	730.00	28.28	0.009

Mean –Force values in Centi Newton, P value > 0.05 statistically significant.

Fig.5 Comparison of Gemini Roth & Tip Edge Brackets with 0.019 x 0.025 inch wires in Dry State



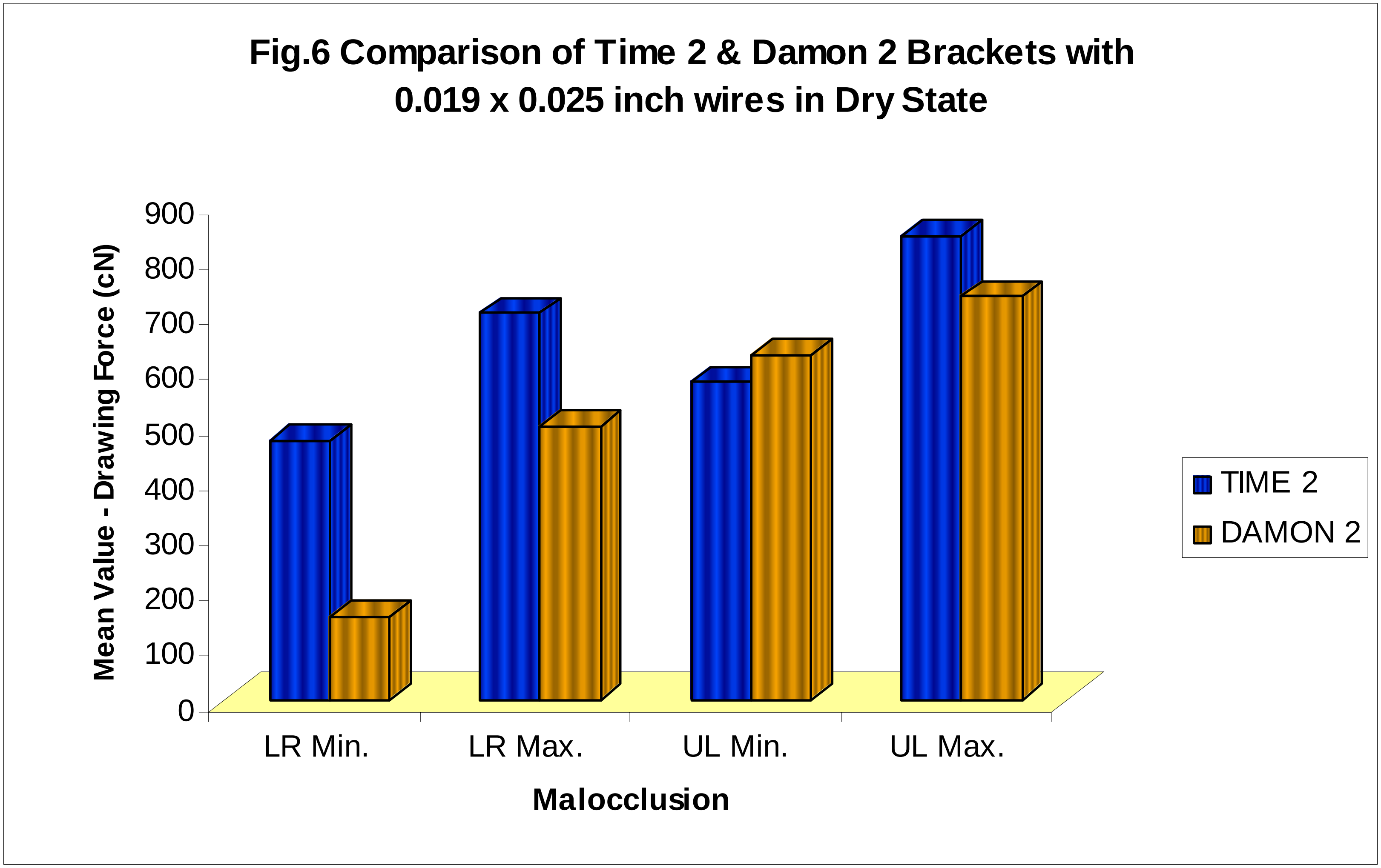


Fig.6 Comparison of Time 2 & Damon 2 Brackets with
0.019 x 0.025 inch wires in Dry State
Mean Value - Drawing Force (cN)
900
800
700
600
500
400
300
200
100
0
LR Min.
LR Max.
UL Min.
UL Max.
Malocclusion
TIME 2
DAMON 2

Table VII

Force values of Gemini Roth brackets in dry states and wet states with 0.014 inch wires

STATE					
	DRY STATE		**WET STATE**		**P Value**
	Mean	**SD**	**Mean**	**SD**	
LR Minimum	200.00	28.28	285.00	35.36	0.117
LR Maximum	655.00	77.78	510.00	28.28	0.132
UL Minimum	185.00	7.07	590.00	28.84	0.180
UL Maximum	745.00	35.36	615.00	28.91	0.539
LL Minimum	280.00	28.28	510.00	28.28	0.015
LL Maximum	825.00	21.21	1040.00	56.57	0.067
UR Minimum	500.00	14.14	600.00	14.14	0.019
UR maximum	960.00	14.14	1190.00	42.43	0.018

Mean –Force values in Centi Newton, P value > 0.05 statistically significant.

Table VIII

Force values of Damon 2 brackets in dry states and wet states with .014 wires

STATE					
	DRY STATE		**WET STATE**		P Value
	Mean	**SD**	**Mean**	**SD**	
LR Minimum	22.50	3.54	42.50	3.54	0.030
LR Maximum	37.50	3.54	52.50	3.54	0.051
UL Minimum	150.00	14.14	115.00	7.07	0.089
UL Maximum	310.00	14.14	235.00	35.36	0.108
LL Minimum	230.00	28.28	255.00	7.07	0.349
LL Maximum	545.00	49.50	435.00	21.21	0.102
UR Minimum	497.00	81.32	515.00	77.78	0.846
UR maximum	835.00	21.21	865.00	21.21	0.293

Mean – Centi Newton, P value > 0.05 statistically significant.

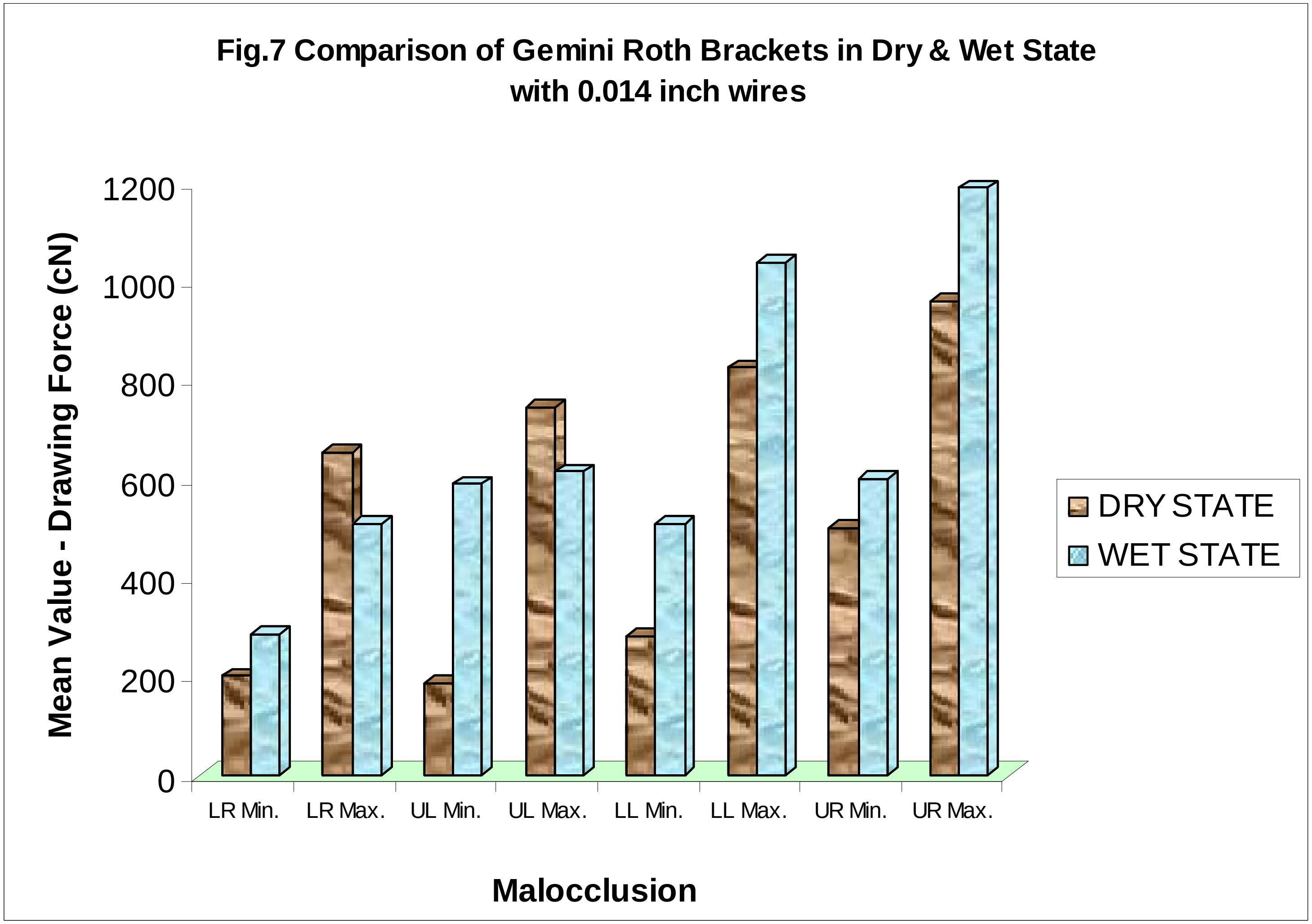


Fig.7 Comparison of Gemini Roth Brackets in Dry & Wet State
with 0.014 inch wires
Mean Value - Drawing Force (cN)
1200
1000
800
600
400
200
0
LR Min.
LR Max.
UL Min.
UL Max.
LL Min.
LL Max.
UR Min.
UR Max.
Malocclusion
DRY STATE
WET STATE

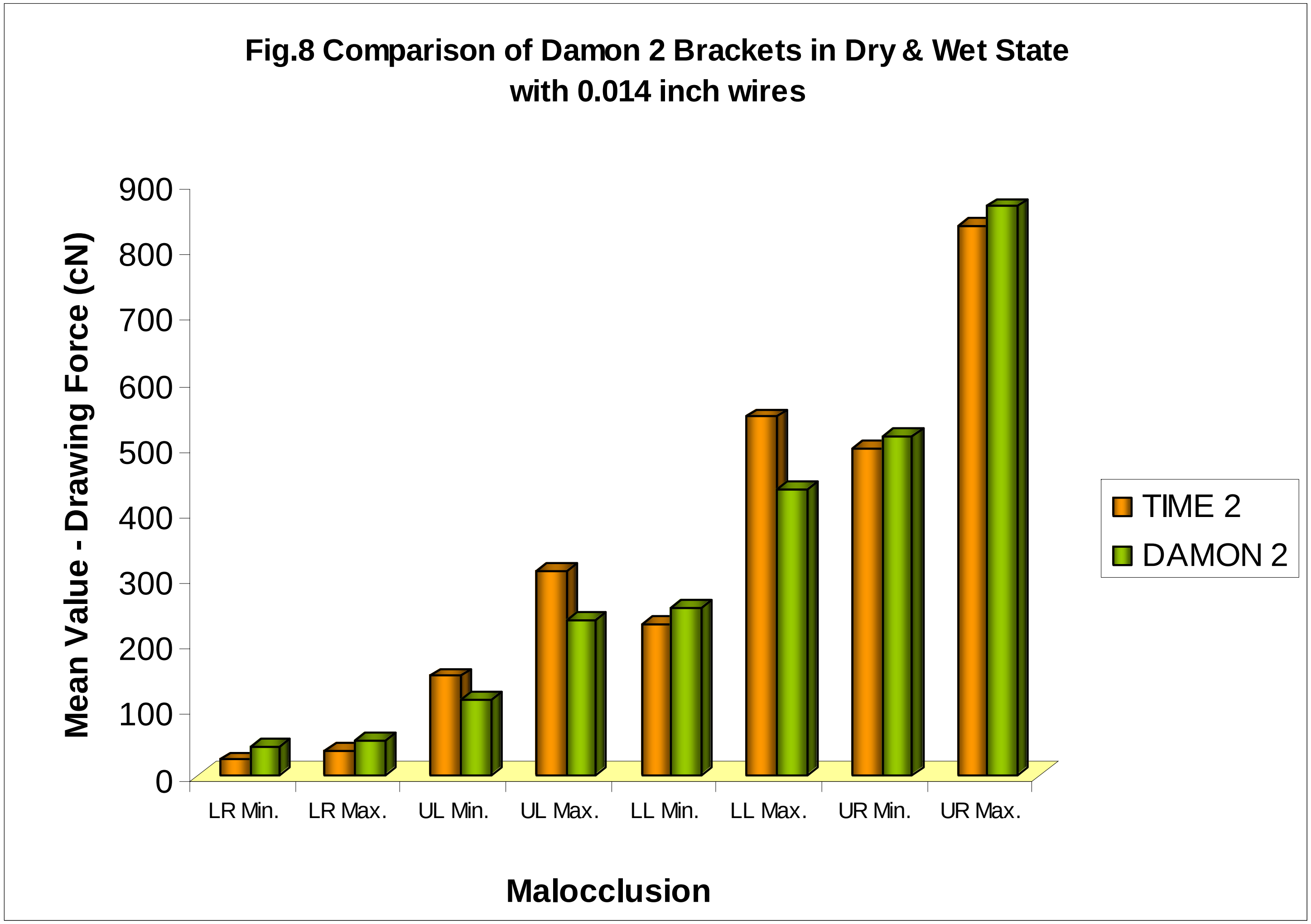


Fig.8 Comparison of Damon 2 Brackets in Dry & Wet State
with 0.014 inch wires
Mean Value - Drawing Force (cN)
900
800
700
600
500
400
300
200
100
0
LR Min.
LR Max.
UL Min.
UL Max.
LL Min.
LL Max.
UR Min.
UR Max.
Malocclusion
TIME 2
DAMON 2

DISCUSSION

Friction is a factor associated in all forms of sliding mechanics[33]. Most of the fixed appliances involve some degree of sliding between the bracket and the arch wire. When ever, sliding occurs frictional resistance is encountered[51]. Friction between the arch wire and the bracket is multi factorial which increase or vary with wire size, angulation of wire to bracket, change in wire shape, change in wire material, bracket width, lubrication, surface roughness and ligature design. Friction exist in two forms (1) Static friction which is the resistance that prevent actual motion and(2)Dynamic friction is the resistance which exists during motion. Several techniques have been used to measure the frictional resistance between the arch wire and brackets such as Dynamometer, a weighted basket or bucket, a force gauge and Universal testing machine[33]. In the present study the tests were carried out by Instron Universal testing machine, as this method of testing was employed by Simona Tecco, Sandra P, Michel Tselepsis and by so many others in their studies. The specific objective of this study is to investigate the influence of frictional resistance by different bracket types, different arch wire size, varying degree of malalignment and lubrication. Various orthodontic bracket wire or ligation combination have been used clinically to reduce the friction. One of the recent invention is the development of self ligating bracket.

The self ligating brackets are ligature less system that have a mechanical device built into the bracket to close off the edge wise slot[50]. The mechanical device which close off the slot is in the form of slide or clip. A self ligating bracket with passive slide does not apply any ligation force to the arch wire, as the slide only covers the slot thus restraining the wire. For a self ligating bracket with spring clip two options exist, when the clip is active it applies a ligation force to fully seat the wire in the slot when passive it does not apply force to the arch wire. Whether the clip is active or passive depends on the size of the arch wire within the bracket[14].

Self ligating brackets are not new, with the Russel attachment being described in 1935, more recently other designs have appeared including SPEED brackets in 1980, the Time brackets in 1994, Damon SL brackets in 1996, Twinlock brackets in 1998 and Damon 2 and Innovation brackets in 2000. The most recent addition are Damon 3 and Smart clip in 2004. Out of all the brackets which are marketed several papers have reported that Damon SL brackets demonstrated lower friction than conventional brackets stating that in case of rectangular wires, the Damon SL brackets was significantly better than other brackets. So it should be preferred if sliding mechanics is technique of choice[39].

Damon SL brackets became available in the year 1996 which was designed by Dwight Damon[22]. These brackets had a slide which moved vertically on the labial surface of an otherwise fairly Twin tie wing brackets. The slide of which clicked into a positive open or shut position and opened in a downward direction in the both the jaws to give a full view of the slot. A tiny U-shaped wire lay under the slide and clicked into the labial bulge on the slide to provide positive open and shut position. These Damon SLI brackets were a major step forward but suffered two irritating problems-slide opened inadvertently and they were prone to breakage. These imperfections led to the development of Damon 2 brackets which retain the same vertical slide action and U-shaped spring to control opening and closing but place the slide within the shelter of the tie wings. Combined with the metal injection moulding manufacture which permit closer tolerances, these developments have almost completely eliminated the inadvertent slide opening or breakage. Another important improvement is reduced size of the bracket[34].

Time bracket is another newer self ligating model that entered the market place in the year 1995. This bracket was designed by Wolf Gang Heiser of Innsbruck, Australia. The time bracket, is the first one piece self ligating system which developed over a period of 3 years using computer technology[55]. Time bracket is a active type of self ligating bracket. The important feature of this bracket is it have rigid curved arm which wraps the slot in a occlusogingival direction around the labial aspect of the bracket body[22]. Time 2 bracket is an improved form of time bracket which utilizes interactive smart clip to provide active and passive treatment options. Another important advantage of this bracket is the smart clip which does not slide along the metal tract to open or close instead uses gentle rolling forces that are more comfortable to the patient.

The advantages of self ligating brackets are more certain full arch wire engagement, low friction between bracket and arch wire, less chair side assistance, faster arch wire removal and ligation. Full engagement of arch wire is an important feature of selfligation, because with a clip/ slide fully shut or not, unintentional partial engagement is not possible. There is no problem of decay of the ligature as with elastic ligatures. Secure full arch wire engagement maximizes the potential long range of action of modern low modulus wires and minimizes the need to regain control of teeth where full engagement is lost during treatment.

Studies have shown that with selfligating brackets substantially lower the frictional value even at high values of active torque. But the study conducted Thorstenson and Kusy on the effects of varying active tip on the resistance to sliding found that angulation beyond the angle at which the arch wire first contacts the diagonally opposite corners of the bracket slot causes rise in the resistance to sliding of both selfligated and conventional brackets. However at all degrees of tip, Damon brackets produced significantly less resistance to sliding. The combination of low friction and secure full engagement is particularly useful in the alignment of very irregular teeth and the resolution of severe rotations were the capacity of the wire to slide through the brackets of the rotated and adjacent teeth significantly facilities alignment. Low friction therefore permits rapid alignment and more certain space closure whilst the secure bracket engagement permits full engagement with severely displaced teeth and full control while sliding teeth along an arch wire.

With thin aligning wires smaller than 0.018 inch diameter the potentially active clip will be passive and irrelevant, unless the tooth is sufficiently lingually placed in relation to a neighboring tooth in case of severe malalignment were the teeth is lingually placed the active spring will touch the wire and this in turn reduces the slot dept. from 0.027 inch to approximately 0.018inch the effects this frequently produces higher force with a given wire for wires >0.018inch diameter the active clip will place a continue as lingual force on the wire even when the wire is passive even when the wire is passive for a typical 0.016x0.022 Nickel titanium wires when used as a intermediate aligning wire for Damon 2 will reduce this potential difference to 0.002inch. in case of lingually placed teeth higher initial force will be produced that the wire touches the active spring clip.

The propose study is to compare the frictional resistance of self ligating and conventional brackets during initial leveling and aligning and in sliding mechanics. In the study two types of conventional brackets (Gemini Roth & Tip Edge) and two types of self ligating brackets (Time 2 and Daman 2) were tested along with three standardized Nickel titanium arch wires (0.014 inch, 0.016 x 0.022 inch, 0.019 x 0.025 inch) typodont models replicated from a patient's oral cavity displaying the misalignment of teeth were used in the study and the drawing force were evaluated in all the four quadrants (LR, UL, LL, and UR) ranking relative to the malocclusion. Total samples tested were 80, 64 samples in dry state and 16 samples in wet state. For each sample friction was measured in centi newton at every 2.5mm displacement fro 2mm. This method was used by Sandra.P and Kusy in his study.

In this study increased friction was encountered with Gemini Roth bracket owing to the use of elastomeric ligation. Apart from the increased friction produced by elastomeric ligation, the elastomertic ligatures exhibit rapid rate of decay and harbour large quantities of plaque which result in decalcification. These demerits suggests that there is little merit in their use, especially in translatory movement and sliding mechanics[40]. In the study Tip Edge brackets showed reduced friction with rectangular wires mainly due to the absence of directly opposed parallel surface in the arch wire slot[37]. With the absence of opposed parallel surface active torque cannot be imparted which in turn reduces the friction[51]. The Time bracket exhibited increased friction due of the force of spring clip. With smaller dimension 0.014 inch wires it was found that there was no significant difference found between the brackets. This is because with smaller dimension wire both Time 2 and Damon 2 brackets behave like passive tube with smaller dimension wires. Out of all the brackets tested in the study Damon 2 brackets encountered lower frictional resistance.

Every self ligating bracket, whether active or passive, uses the movable fourth wall of the bracket to convert the slot into a tube. Numerous studies have demonstrated a dramatic decrease in friction for self-ligating brackets, compared to conventional bracket designs. Such a reduction in friction can help shorten overall treatment time, especially in extraction cases where tooth translation is achieved by sliding mechanics.

In the study Gemini Roth and Daman 2 brackets with 0.014 inch wires were tested for comparison in dry and wet state. For this test saliva of investigator was used. This method was adopted by Sandra in his study. Human saliva was preferred over saliva substitute because the artificial saliva produced higher frictional resistance because of the rapid rate of desiccation with cellulose adhering to the arch wire[40]. The saliva was applied to the brackets using syringe. In the study conducted it was found that with 0.014 wires Daman 2 brackets and Gemini Roth brackets exhibited higher frictional force in wet state compared to dry state as it was found in the study done by Glenys A Thorstorsen. It is explained that the increased friction encountered during wet state is due to atomic attraction between the saliva particles[19]. Adhesion theory of friction refers to the increase in friction by the presence of polar liquid creating an increased attraction among the ionic species leading to adhesion, which in turn increases the friction[2].

The study agree that currently available self ligating brackets offer low frictional compared to the conventional bracket system by using bracket system that are self ligating one can decrease the treatment duration, and anchorage requirement particularly in cases requiring large tooth movements, these promote oral hygiene and eliminate any chance of soft tissue laceration to patient and orthodontist from the use of stainless steel ligature wires. It is not unrealistic to expect that one day self ligating bracket system will become the only bracket system of choice.

In multibracket testing performed it was found that self ligating brackets when coupled with smaller A Niti wires showed lesser frictional force compared to the conventional brackets when coupled with larger wires. The outcome of the study emphasize the importance of alignment and leveling before using larger wires. The result also showed that there was slight increase in the values from quadrant to quadrant, which corresponds to increase in malocclusion. This increase is directly related to combined effects of decreasing clearances and interbracket span.

SUMMARY AND CONCLUSION

The study was evaluated and comparison of the frictional resistance of 2 types of conventional and 2 types of self ligating bracket design with three A NiTi wires of varied dimension using dental typodont depicting varying degree of malalignment was done. The result of the study showed that out of all the brackets tested the Gemini Roth bracket showed increased resistance owing to elastomeric ligation and Damon 2 brackets exhibited the lowest friction. The lowest friction exhibited by Damon 2 brackets was mainly due to its passive design. However when both Damon 2 and Time 2 brackets were compared with smaller dimension 0.014 inch wires, it was found that there was no significant difference found between the brackets. This is because with smaller dimension wire both Time 2 and Damon 2 brackets behave like passive tube.

In the study when the Gemini Roth and Damon 2 brackets were tested for comparison in dry and wet state, it was found that both the brackets exhibited increased friction in wet state. It is explained that the increased friction is mainly due to the atomic attraction that exist between the saliva particles.

The study also enumerate that during aligning and leveling phase the ideal wire of choice is the smaller dimension wires. Larger dimension wires are not advised during aligning and leveling phase because with larger dimension wire more frictional force is encountered between the bracket and the arch wire which in turn decreases the tooth movement.

With the advent of self ligating system it is becoming apparent that stainless steel and elastomeric ligatures will eventually be out dated as full banding is today. The current brackets are able to deliver measurable benefit with good robustness and ease of use, although further refinements and further studies are essential.

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